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LONG-TERM TRENDS IN CEREAL YIELDS AT PENDLETON

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INTRODUCTION

The yield of cereal grains, as well as that of many other crops, has risen over the years in response to variety improvement, better weed and disease control, greater water conservation techniques, and improved fertility management. The Pendleton Agricultural Research Center maintains several long-term experiments from which it is possible to extract trends in crop yield over time. The Center is located in the 16-18 inch precipitation zone which is the transition zone between annual cropping and wheat/fallow rotations. We often encourage annual cropping over a wheat/fallow rotation because it is much more effective in maintaining soil organic matter and other soil quality relations in areas traditionally prone to high soil erosion rates. Winter wheat yield is normally higher after fallow than after annual cropping. But the difference is not wide and has been closing in recent years. Is this the result of more efficient varieties better adapted to using water more efficiently? Or is it due to better growing conditions because of periodic fluctuation in the climate? We present and interpret some of the changes that have occurred over the past 60 years.

ROTATIONAL EFFECTS ON WINTER WHEAT YIELD

The nine-year moving average (average of 9 previous years) for winter wheat yield following fallow, spring peas, and winter wheat is presented in Figure 1. While the general trend has been steadily upward, there was a sharp jump in the mid

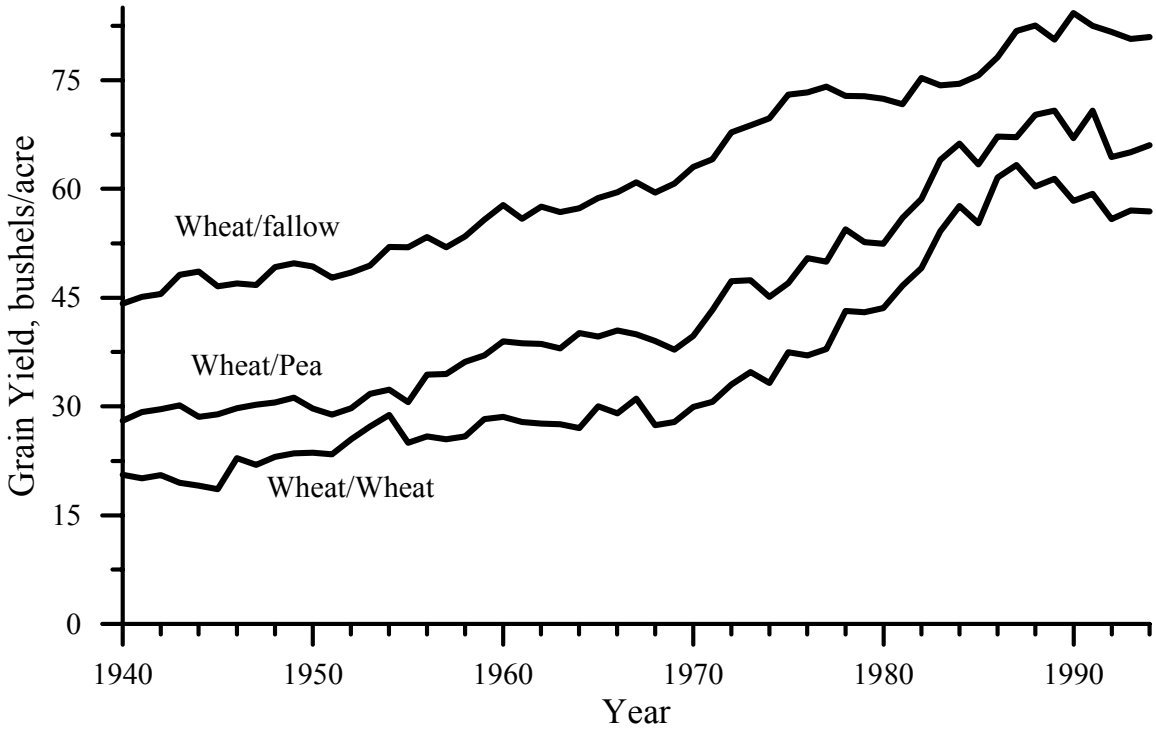

Figure 1. Nine year moving average of wheat grain yields following fallow, spring peas, and winter wheat at the Pendleton Agric. Res. Ctr., 1940-1994.

1960s after the introduction of semi-dwarf wheat. The upward trend since 1967 is more difficult to interpret, since it coincides with a very favorable winter weather pattern (Figure 2). The drop in yield the past 8-9 years appears highly related to a sharp drop in winter precipitation. The cropping trend is especially true for wheat grown annually, but also occurs for wheat following fallow. Variations in precipitation levels must be closely investigated when analyzing long-term yield trends, because drought stress occurs most years.

Wheat yield for annual cropping rose the same amount (24 bushels/acre) for the 1967-94 period as did yield for wheat in a wheat/fallow rotation. This strongly suggests that semi-dwarf wheats have better water-use efficiency (WUE) than the older medium-tall varieties. Most of the WUE is presumably attained by less winter dormancy, which permits earlier more vegetative growth in the spring before the onset of hot dry conditions. While differences in winter wheat yield between fallowing and annual cropping continue to decrease, there is greater fluctuation in winter wheat yield in annual cropping because of greater sensitivity to drought stress when it occurs. Thus, while it may be more profitable to annual crop, the risk of crop failure is higher.

Within annual cropping, there is about a 10 bushel/acre gain in winter wheat yield following spring peas compared to following winter wheat. Some of the difference can result from less depletion of soil water by peas than wheat the preceding year, but the rotational effect also contributes strongly. Rotation to a legume decreases the intensity of many soil-borne wheat diseases. No special disease management practices have been applied to these experiments.

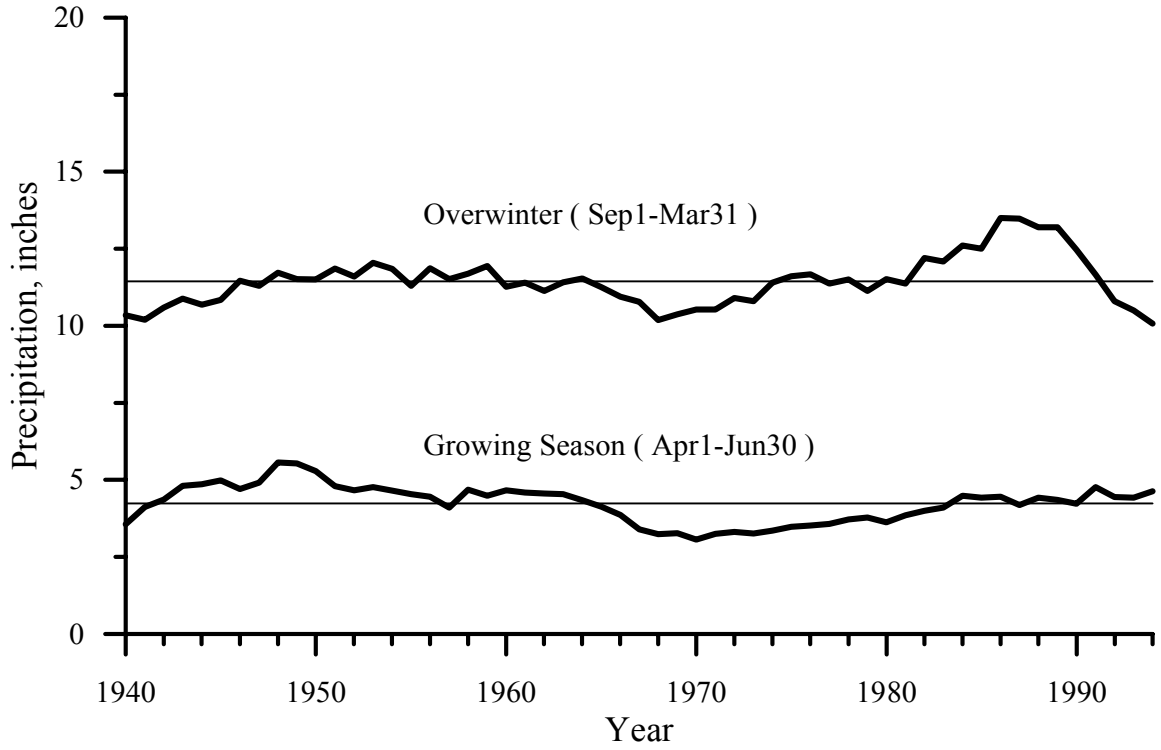

Figure 2. Nine year moving average overwinter and growing season precipitation at the Pendleton Agric. Res. Ctr., 1940-1994.

PRECIPITATION EFFECTS ON WHEAT YIELD

Winter wheat following peas is slightly more sensitive to the amount of overwinter precipitation than is wheat following fallow (Figure 3). Winter wheat following peas also responds much more to growing-season rainfall than does wheat following peas (Figure 4). This could be due to both a larger effect on total precipitation, or to greater late-season drought stress produced by lower total water available and slightly later seeding dates. The sensitivity of wheat yield to precipitation is usually much greater for semi-dwarf wheat grown after 1967 than for the taller varieties grown earlier. Growing-season precipitation has a much greater effect on yield than does winter precipitation. In the wheat/pea rotation, each additional inch of winter precipitation is worth about 2.4 bushels/acre, and each additional inch of growing-season rainfall is worth 9.7 bushels/acre.

In Figures 3 and 4, there is a fairly wide fluctuation in yield, even under specified conditions. A number of other factors affect wheat yield, such as soil temperature, efficiency of water storage, intensity of disease and weed infestation, stand establishment and tillering, and high air temperatures at flowering. Often, many of the variables are related, (e.g. precipitation and temperature) so that the effect of any single variable is difficult to interpret. We can presently define some of the variables that affect wheat yield, but our precision is fairly low. Maintaining and analyzing long-term experiments give us a start towards better prediction of yield under a variety of cropping systems.

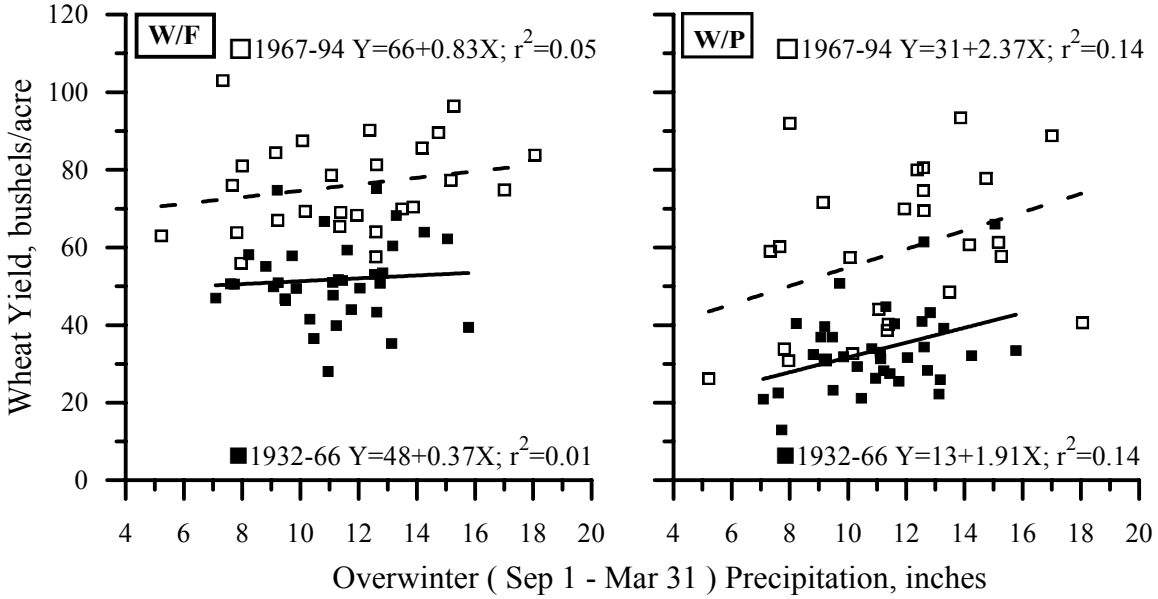

Figure 3. Sensitivity of wheat yield to the level of overwinter precipitation when grown following fallow or spring peas. 1932-1966 (medium tall wheat) and 1967-1994 (semi-dwarf wheat). Pendleton Agric. Res. Ctr.
W/F = wheat/fallow W/P = wheat/pea crop rotation.

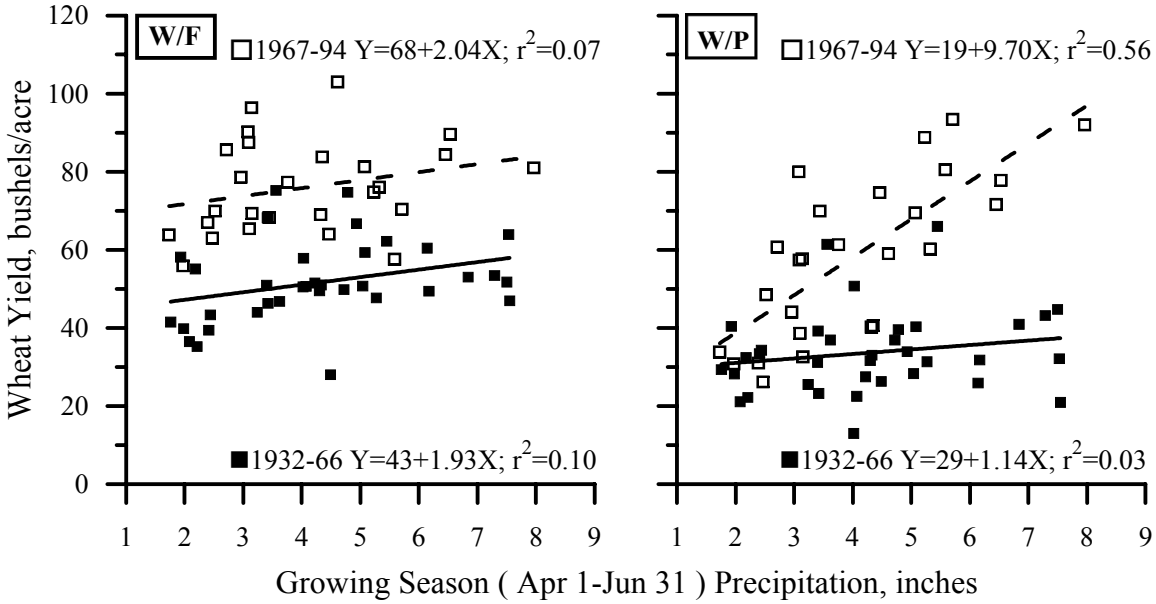

Figure 4. Sensitivity of winter wheat yield to level of growing-season precipitation when grown following fallow or spring peas. 1932-1966 (medium tall wheat) and 1967-1994 (semi-dwarf wheat). Pendleton Agric. Res. Ctr.
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